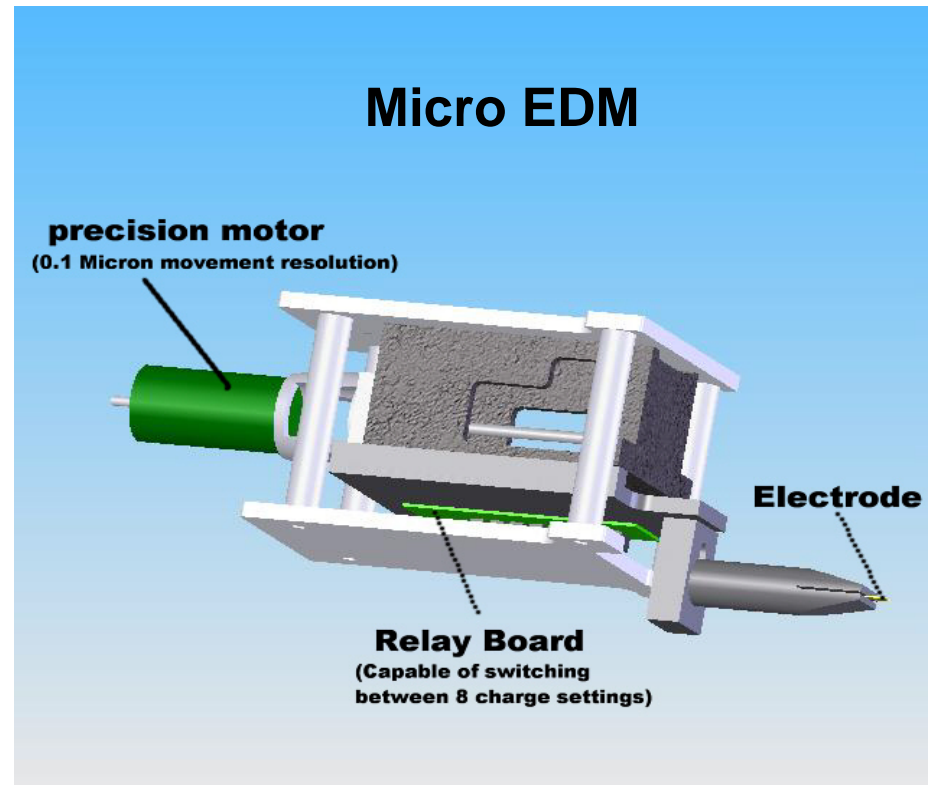


# EDM Dressing of Fine Grinding Tools in Bare Be Surfacing

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## **Problem Statement**

**Fine grinding of Be optical surfaces balances two competing objectives:**

- 1) Minimizing residual stress profile created in the Be surface**
- 2) Maximizing material removal rate and material removal rate temporal stability**

***“Coarser grit grinding tools have higher removal rates, and degrade in rate over time more slowly relative to total material removed, but impart higher subsurface stress profiles.”***



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## **Technical Approach**

**Develop an EDM based tool dressing technique that will**

- 1. Improve removal rates for a given grit size tool**
- 2. Improve temporal stability of removal rates**

**and in doing so.....**

**Allow finer grit tools, with their corresponding lower stress profiles, to be planned into bare Be surfacing.**



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## Summary Results to Date

1. EDM dressing improves average removal rates for a given grit size tool
2. EDM dressing improves removal rate temporal stability for all grit sizes
3. Satisfactory removal rate parameters have been identified for medium grit tools



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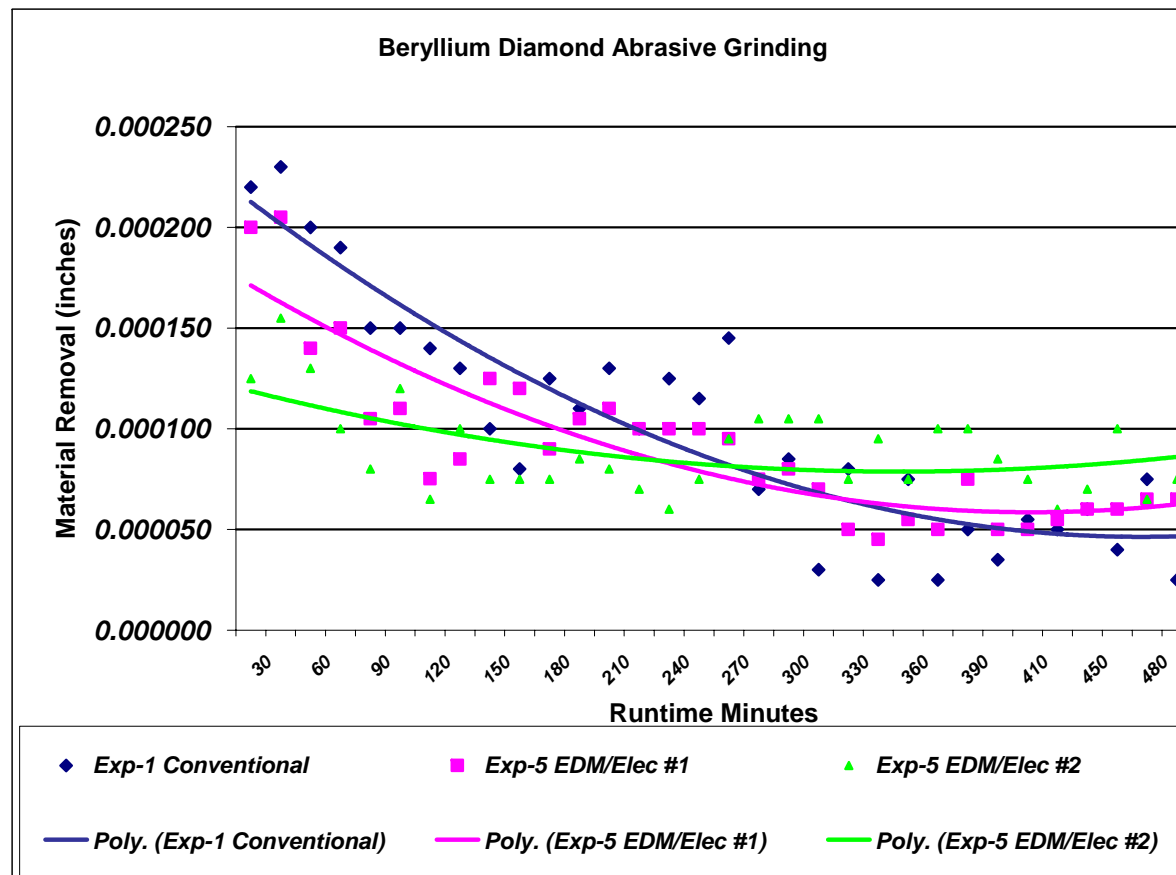
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## Phase 1 SBIR Results

- EDM dressing was initially proposed to deal with tool wear
- An EDM unit was integrated into a fine grinding process.
- Linearity of removal rate (green curve) improved over non-EDM grinding (blue curve)



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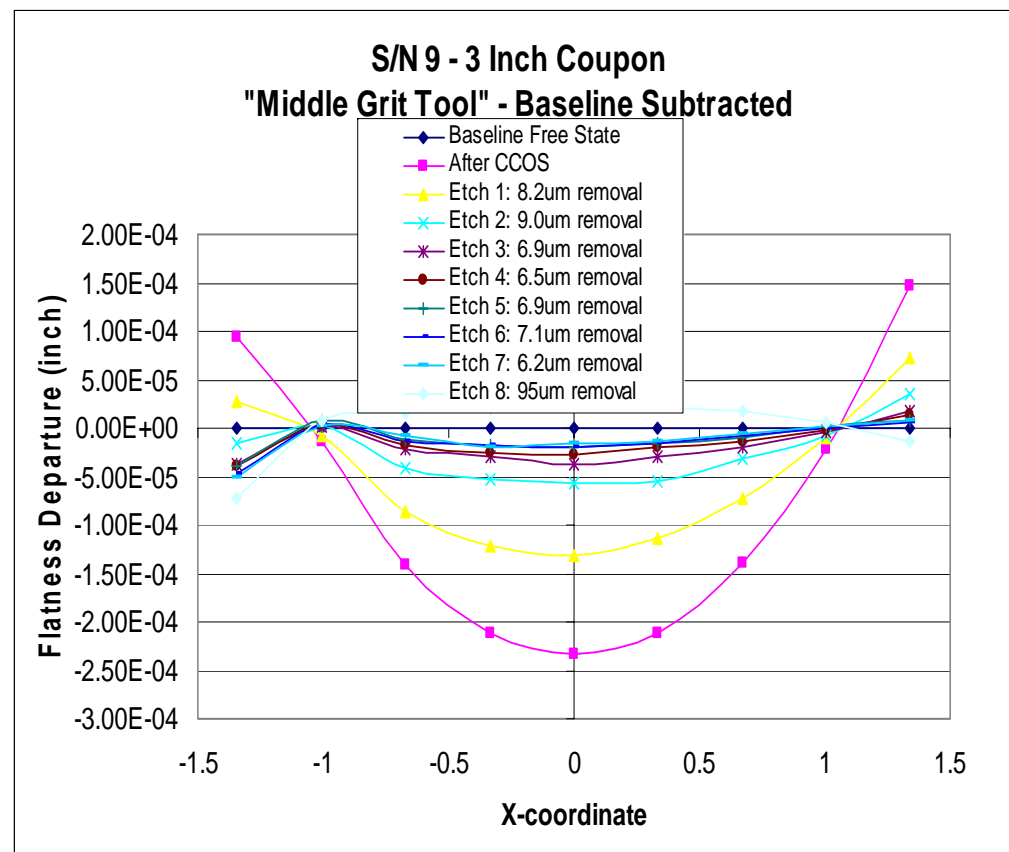
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## Key Question in Initiating Phase II Development of EDM

What is stress profile coarser grades of grinding tools leave in surface of Be? How much less stress do finer grade tools generate?

### Experiment

1. Etch/polish both sides of Be disc
2. Measure S2/grind S1/measure S2/etch S1/measure S2/etch S1/measure S2/etch S1/...
3. Calculate stress profile



Surface sag in 3" disc through series  
of etches after grinding



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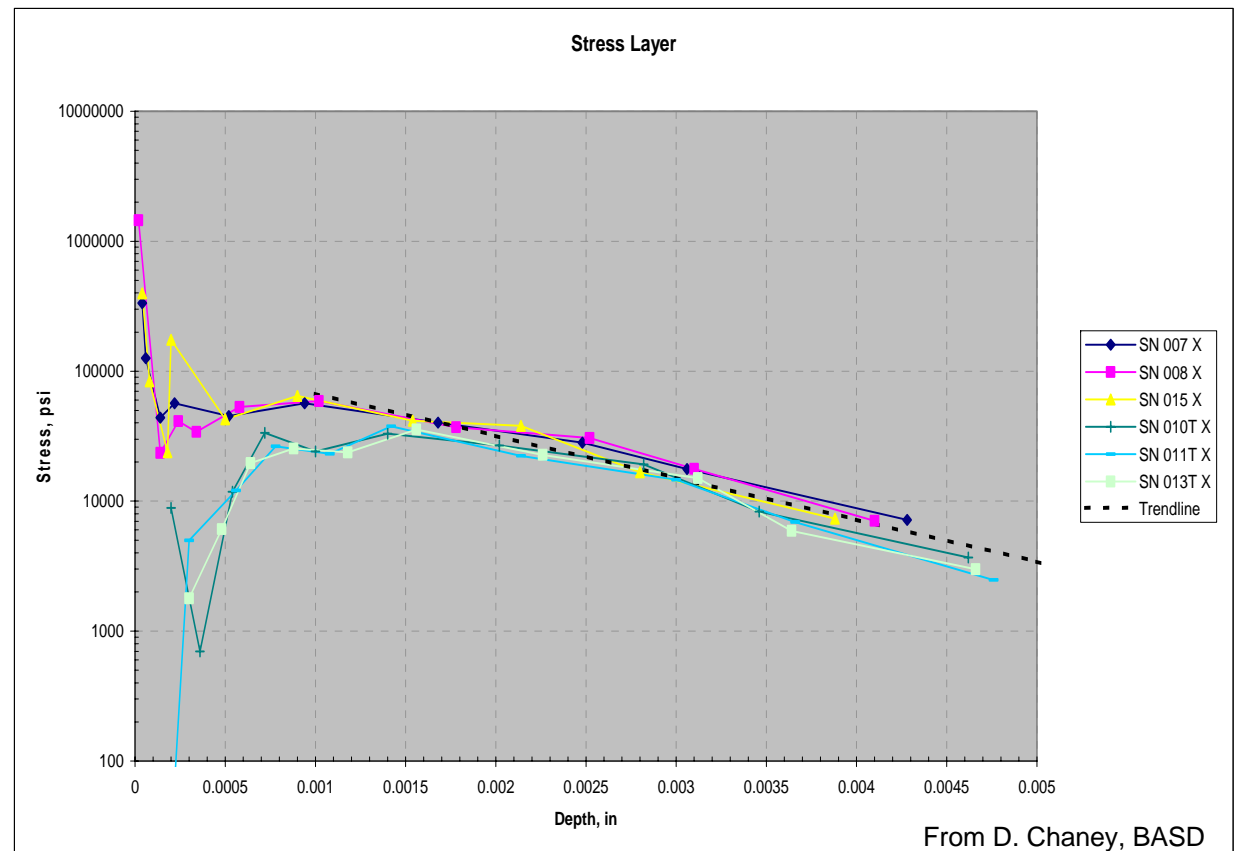
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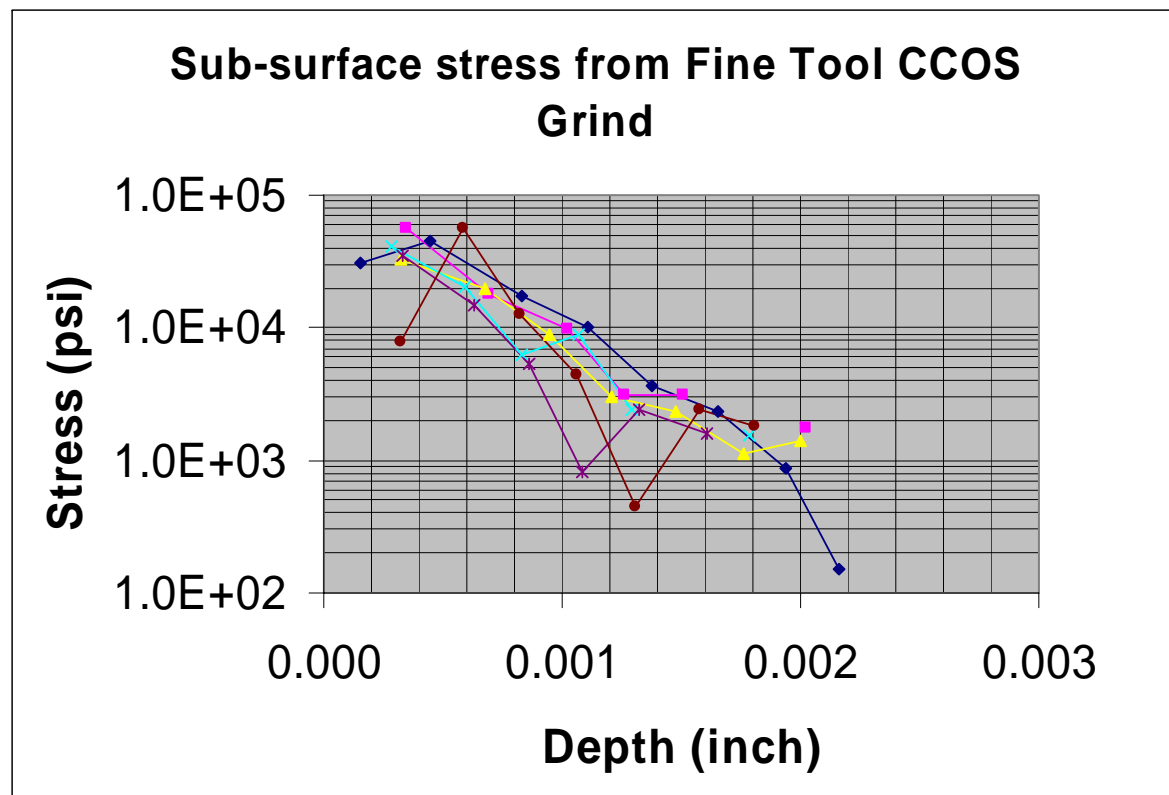
## Sub-surface Stress Profile with AMSD Type Grind Tool

- AMSD type grinding tool experiments were performed on 6" discs
- Experimental Plan: Grind coupon top surface, measure back surface through series of thermal cycles and ground surface acid etches
- 100ksi seen @ surface
- 10ksi seen @ 0.0035" into surface
- Extrapolating stress-depth curve suggests 1ksi @ 0.007" depth



# Sub-Surface Stress Profile with Fine Grit Tools

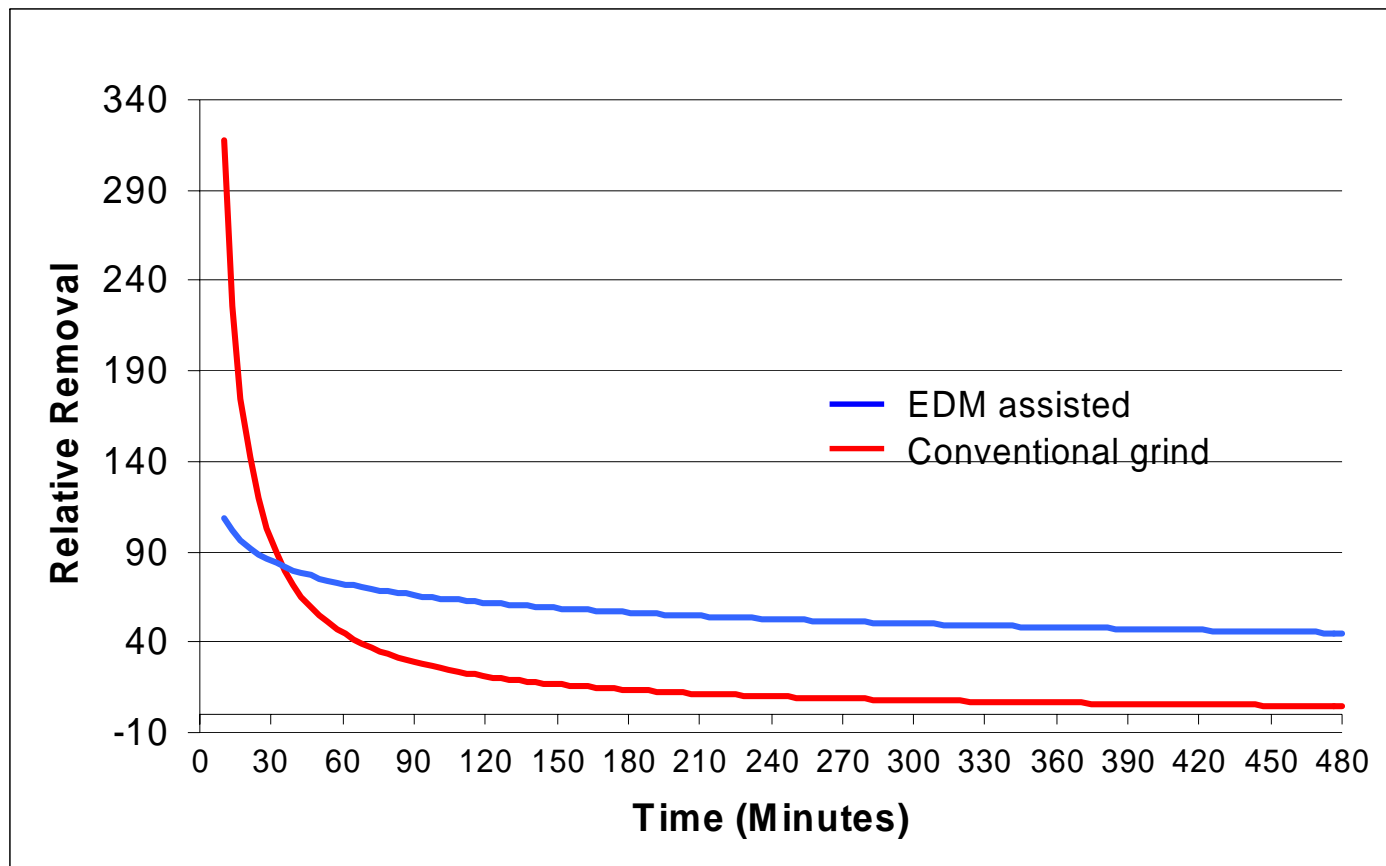
- Stress profiles were measured for a series of fine grit tools
  - 1ksi damage threshold reduced from ~0.007" depth in material to ~0.002" depth in material
    - Removal rates with these finer grit tools were relatively low though





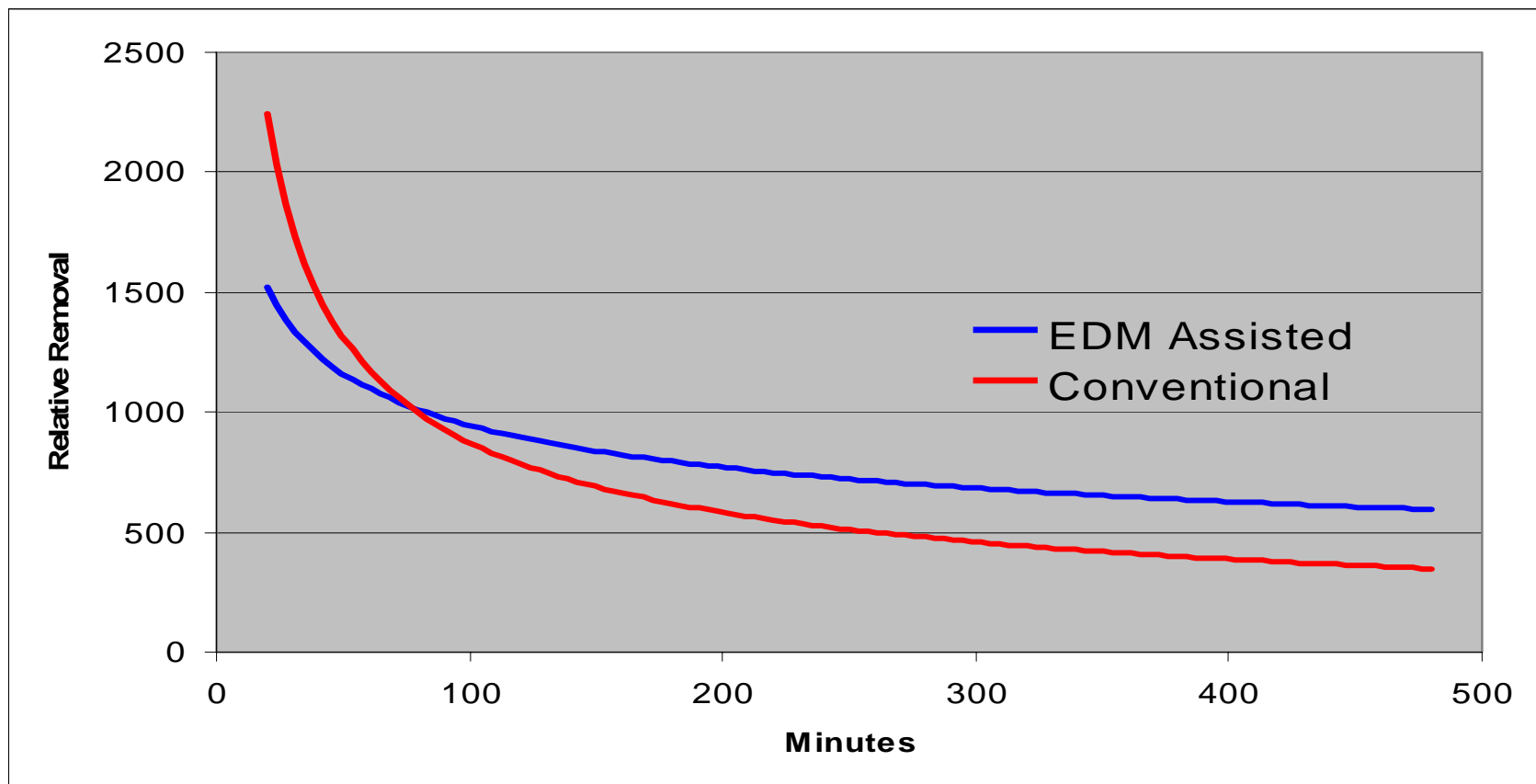
## Initial Results: Fine Grit Tool

- Less degradation in removal rate is seen with EDM assisting grind, and average removal rate also improves
- EDM removal rate continues flat beyond 480min, while conventional removal rate continues to degrade



## Initial Results: Medium Grit Tool

- Conventional grind rate degradation is less dramatic with medium grit tools, but EDM still generates a significant improvement



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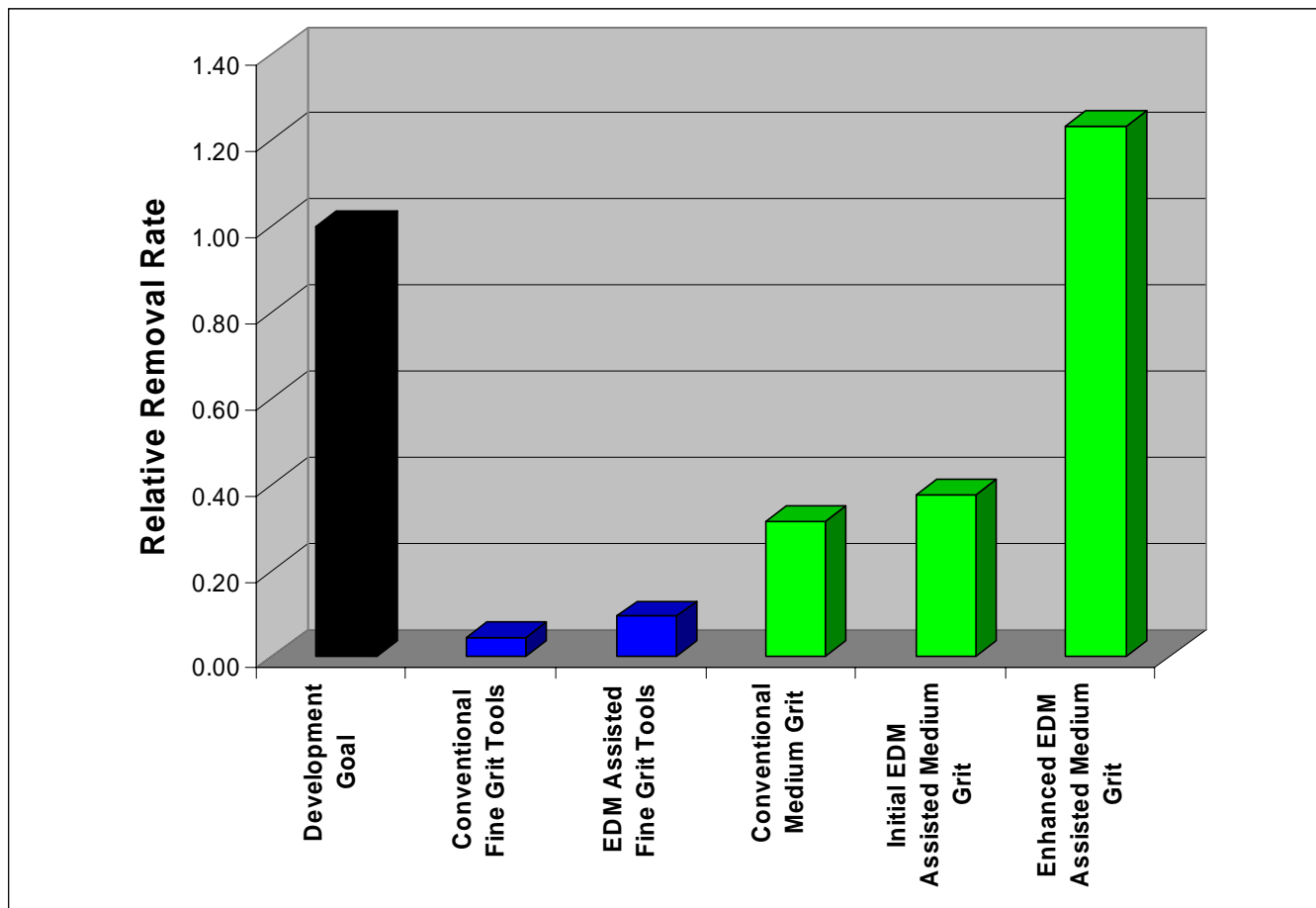
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## Removal Rates

- With medium grit tools, and process optimization to date, removal rates are satisfactory.



## Plans & Acknowledgements

- Continue screening process parameters for removal rate improvement
- Evaluate stress sag for improved processes
- Demonstrate process on a sub-scale flight type mirror

Our thanks to Phil Stahl for supporting this work, and to Dave Chaney for collaborating on stress profile development for the AMSD grind process.



12" demonstration mirror



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